Statistical Significance

A county's observed rate should be thought of as an estimate of the true underlying rate. The number of events (birth, death, hospitalization, etc.) in a county varies by chance, depending on the number of county residents and the probability of the event. Because of this, rates based on small numbers are unstable. Therefore, tests for statistical significance were performed to determine the probability that the differences between county rates and the corresponding state/regional rates were the result of chance.

If "YES" was present in the "significantly different" (Sig.Dif.) column, there is a 95 percent probability that the county rate was either higher or lower than the state/regional rate. Conversely, there is only a 5 percent probability that the difference between the county's rate and the state/regional rate is due to chance or random error. If "NO" was present, it could not be stated that the difference between the county rate and state/regional rate is not not due to random error; the difference is not statistically significant.

Tests for Significance Utilized in CHAI's

The test for significance at the 95% confidence level differs depending on the number of events (birth, death, hospitalization, etc.).

When at least one of the rates is based on fewer than 100 events

When comparing two rates, when one or both of these rates are based on less then 100 events, confidence intervals were computed for both rates. If the confidence intervals overlap, the difference is not statistically significant at the 95% level. If they do not overlap, the difference is statistically significant.

95 % confidence intervals for rates based on less than 100 events were generated using the following formula and values in Table 1:

      Lower limit = R x L
      Upper limit = R x U

where:

      R = the rate (mortality rate, hospitalization rate, etc.)
      L = the value of L in Table 1 that corresponds to the number N in the numerator of the rate
      U = the value of U in Table 1 that corresponds to the number N in the numerator of the rate

Confidence intervals for rates when the numerator is 100 or more were generated using the following formula:

      Lower limit = R - [1.96 (R/$\sqrt{N}$)]
      Upper limit = R + [1.96 (R/$\sqrt{N}$)]

where:

> R = the rate (mortality rate, hospitalization rate, etc.)
> N = the number of events

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Example: Comparing Rates When One is Based on Less than 100 Events

For 2000-02, County A has a neonatal mortality rate of 6.2/1000 births (46/7400) compared to the State rate of 4.2/1000 (3210/762,787).

County A has the number of events less than 100

> Lower limit = 6.2 x L (0.73213) = 4.54
> Upper limit = 6.2 x U (1.33386) = 8.27

State has more than 100 events

> $R \pm 1.96 \, (R/\sqrt{N})$
> $4.2 \pm 1.96 \, (4.2/\sqrt{3210})$
> 4.2 ± 0.15

	Lower Limit	Upper Limit
County	4.54	8.27
State	4.05	4.35

The two confidence intervals do not overlap. Therefore the difference in neonatal mortality between County A and the State is statistically significant.

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When both rates are based on 100 or more events

If comparing rates that were both based on 100 or more events, the difference between the two rates was calculated (subtracting the lower rate from the higher rate). This difference was considered statistically significant if it exceeded the statistic in the formula below:

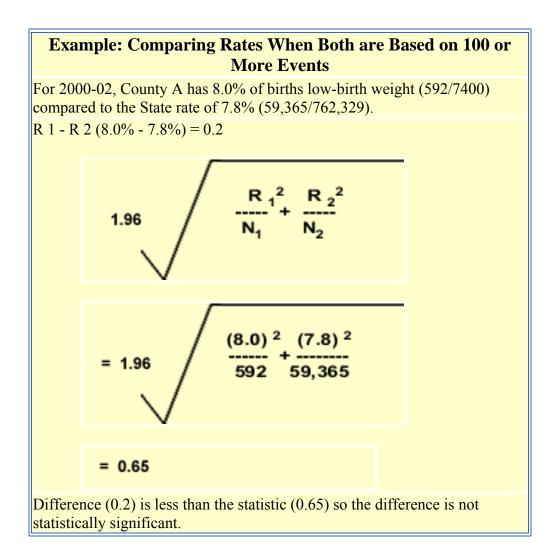$$= 1.96 \sqrt{\frac{R_1^2}{N_1} + \frac{R_2^2}{N_2}}$$

where:

> R 1 = the first rate
> R 2 = the second rate
> N 1 = the first number of events

N 2 = the second number of events

When the difference between the rates was greater than this statistic, the rates were statistically significant at the 95% confidence level; the difference would occur by chance less than 5 times out of 100. When the difference between rates was less than this statistic, the difference was not statistically significant; the difference might occur by chance more than 5 times out of 100.

Example: Comparing Rates When Both are Based on 100 or More Events

For 2000-02, County A has 8.0% of births low-birth weight (592/7400) compared to the State rate of 7.8% (59,365/762,329).

R 1 - R 2 (8.0% - 7.8%) = 0.2

$$1.96 \sqrt{\dfrac{R_1^2}{N_1} + \dfrac{R_2^2}{N_2}}$$

$$= 1.96 \sqrt{\dfrac{(8.0)^2}{592} + \dfrac{(7.8)^2}{59,365}}$$

$$= 0.65$$

Difference (0.2) is less than the statistic (0.65) so the difference is not statistically significant.

When rates are age-adjusted

When comparing two age-adjusted rates the difference between the rates need to be calculated. Then the 95% confidence intervals of the difference also must be calculated (See Breslow & Day). The difference is calculated by subtracting one rate from the other rate. The 95% confidence intervals of the difference are calculated using the following formulas:

Lower limit = D - [1.96*SE(d)]
Upper limit = D + [1.96*SE(d)]
Where:

D = the difference in value between the rates
SE(d) = the standard error of the difference(minimum variance method)

If either the upper limit is below 0 or the lower limit is above 0 then the difference of the two rates is significantly different from 0, meaning the two rates are significantly different from each other.

To calculate the standard error of the variance the minimum variance method was used as follows:

$$SE(d_{min\ variance}) = \sqrt{\dfrac{\sum\limits_{i=1}^{k} w_i p_i (1-p_i)}{\sum\limits_{i=1}^{k} w_i}}$$

Where, p_i are the overall stratum-specific rates (both study groups combined):

$$p_i = \dfrac{x_{iA} + x_{iB}}{n_{iA} + n_{iB}}$$

X_i = the stratum-specific number of events

N_i = the stratum-specific number of population

and w_i are the standard population weights used to adjust the study group rates:

$$w_i = n_{iA} \times n_{iB}$$

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$$n_{iA} + n_{iB}$$

Bibliography:

Breslow, N.E. and Day N.E.. Statistical Methods in Cancer Research Volume II - The Design and Analysis of Cohort Studies (pp.445-447). Oxford University Press, 1994.